

25X1

NPIC ROUTING SLIP

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FROM:

DATE:

31 March

FOR YOUR

	TO	INITIALS	DATE	SIGNATURE	INFORMATION	COMMENTS	CONCURRENCE	APPROVAL	ACTION	SEE REMARKS BELOW	FILE	RETURN	SEE ME
DIR													
DEP/DIR													
EXEC/DIR													
ASST FOR OPS													
ASST FOR ADMIN													
ASST FOR P&D													
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CH/PSD													
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CH/TID													
SIO/CIA (PID)													
SIO/ARMY													
SIO/NAVY													
SIO/AF													
LO/DIA													
LO/NSA													

✓ JWC 1 April 63

John - Per ACL  
note - please get  
concurrence from  
DD/R - or  
no objection -  
and bring package  
to me for sign off.  
C. F. C.

REMARKS:

*Act: [Signature]*

*Please review  
the Aetheric Optical  
Systems proposal*

*by [Redacted]  
[Redacted] other  
two items are quite  
simple. Pls advise  
just them.*

*C.T.K.*

*Check —*

*This is fairly fundamental research.  
I have no objection as long as*

*along with us. A.C.L.*

1 March 1963

MEMORANDUM FOR: Assistant for Plans and Development

THROUGH : Executive Secretary, TDC

SUBJECT : Staff Study - Evaluation of Proposal, Aspheric Optical Systems, Solicited from the [REDACTED]

PROBLEM

1. There exists a requirement for higher quality lenses for the taking and exploitation of reconnaissance photographs. The area of exploitation, particularly, needs considerably better lenses for projection printing and screening viewers.

FACTORS BEARING ON THE PROBLEM

2. Facts

a. From the beginning the art/science of lens design has utilized formulas based on the spherical surface almost exclusively. This is especially true in refractive type lenses as are those on enlargers and projectors.

b. All lenses, particularly those of large aperture and of reasonable half-angle (15 degrees or larger), are burdened with the gamut of characteristic aberrations; they are astigmatism, coma, lateral and axial color, spherical and field curvature and distortions to mention the most important. These aberrations are reduced by manipulating the index of refraction and dispersion of the optical glasses used in the different elements, the curvature of the surfaces, and the combination and spacing of the elements. No lens utilizing the spherical surface design in its calculation can be "fully corrected" to relieve it of these aberrations.

c. A lens can be designed to be diffraction limited for the optical axis image and for images falling as much as 5-7 degrees off axis (see Definitions for diffraction limit criteria). The inability to fully correct the inherent aberrations still makes this achievement difficult requiring numerous glass elements both cemented and air spaced. With the increase in numbers of elements, particularly air spaced, the light transmitted by the lens is significantly reduced. The ability to achieve the diffraction limit further off the optical axis is out of the question following present design criteria.

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d. As far back as 1630, Descartes disclosed the geometrical design of a single element lens free from spherical aberration. The description had one surface a portion of an ellipse and the other surface was spherical with its center of curvature as one of the foci of the ellipse. The ellipse together with the parabola and the hyperbola comprise the examples of what may be described as aspheric or non-spherical surfaces of revolution each having particular properties when used as refracting or reflecting surfaces. The reason for not designing lenses utilizing aspheric surfaces since the original by Descartes has been the insurmountable mechanical problem of grinding, polishing, and retaining the high degree of accuracy of centering during assembly of the elements. During and since World War II great strides have been made in the lens grinding and polishing craft in the realm of generating the non-spherical surface to the point where some lenses in which one of the surfaces is aspheric are in commercial production. Still in many of the larger lenses, utilizing an aspheric surface in their design, the aspheric surface is hand made; the economics of production preclude their use except in special cases.

e. In a search of the literature and in consulting with [redacted] I have concluded without reservation that the time is right to study and design lenses in which all elements are aspherized.

3. Definition - The criteria for the diffraction limit of a lens in a function of the wavelength of light and the physical diameter or lens aperture, the limit being the separation of the diffraction pattern image of two very close point light sources formed by the lens. This diffraction pattern is better known as the Airy disc.

#### DISCUSSION

4. The state of the art in lens design is at a point where one or more aspheric surfaces can be incorporated in a lens design to more nearly achieve the goal of a "fully corrected" lens. By assuming the philosophy of aspherizing all of the lens surfaces the number of elements can be significantly reduced, the light transmission can be increased also by a significant amount, some aberrations eliminated and others reduced to a bare minimum, the diffraction limit extended across very nearly the whole angular coverage and the angular coverage increased if desired.

5. I have consulted [redacted] and he is in agreement with me that a study and design of a totally aspherized lens is appropriate at this time. In fact, he feels that the basic triplet lends itself ideally to this study. He has recently completed an extensive analysis of the triplet lens with all spherical surfaces and is perhaps the only person to have accomplished this

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feet. Having an IBM 7090 computer at his disposal at the University has made it possible. He assures me that the programs written for the triplet analysis can be utilized to run the design study and analysis of the all aspheric triplet.

25X1 6. [ ] is quite concerned about the accurate and economical generation of the non-spherical surface. Even though the Air Force has contracted  
25X1 [ ] to study mechanical methods of generating the aspheric surface he has misgivings about the particular approach. He briefed me on a method that he wishes to explore; the generation of the surface by evaporative means. He has as an associate one of the authorities in the field of evaporative methodology for multilayer systems (narrow band-pass filters), [ ]  
25X1 [ ] I am convinced that this study should go hand in hand with the lens design study and asked that it be included with the solicited proposal for the lens design. The method appears feasible and should be explored.

CONCLUSIONS:

7. A major obstacle in the terminal quality of the product to be exploited by a screening viewer or projection printer is the quality of the lens. Significant improvements in this area of lenses will significantly improve the exploitation job, whether it be the interpretation of a screened image or a print.

8. The study of a totally aspherized group of lenses is timely and will result in design criteria for future requirements. The present state of the art cannot satisfy the future requirements too much longer.

9. The "sister" applied research effort in Evaporative Research for non-spherical lens surface generation is appropriate and should proceed simultaneously with the lens design study.

25X1 10. The [ ] price tag for two years work is quite economical. This will in no way impair the quality of the research which will be quite high.

RECOMMENDATIONS:

25X1 11. It is recommended that the [ ] proposal be accepted  
25X1 and an unclassified [ ] contract be negotiated as soon as possible in accordance with this proposal for the amount of [ ]

12. It is further recommended that the following be incorporated in the contract:

a. A quarterly letter report be submitted to the contracting officer and the technical monitor. This letter will contain the following information:

1. Problems investigated and conclusions reached concerning the research.

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2. Work plans for the forthcoming quarter.
  3. An account of percent of contract complete and funds remaining.
  4. Report when 85% of the funds have been used.
- b. Sketches, diagrams, and photographs etc. should be made and submitted periodically to be used for briefing materials.

[Redacted]  
Development Branch, P&D

25X1

APPROVED: \_\_\_\_\_  
Executive Director, NPIC

\_\_\_\_\_  
Date

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